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E-book reading in kindergarten and story comprehension support

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Abstract

We examined intervention programs using an e-book with expansions for promoting story comprehension developed for this study. In program (a), teachers received coaching on how to support the children while activating the e-book with expansions aimed at supporting the story content; in program (b), the children worked independently with the e-book with expansions; in program (c), the children worked with the e-book without expansions (control). In all three programs, the children read the e-book in the kindergarten six times over the course of three weeks. The participants included 160 kindergarteners (aged 5–6) from LSES neighborhoods. A clear advantage was found for children whose teachers received coaching on e-book reading, followed by children's independent reading of the e-book with expansions. The control group showed the least progress. Children with a low initial level in story comprehension demonstrated the biggest progress. The findings and their implications are discussed.

Keywords E-book reading · Story comprehension · Kindergarten children · Kindergarten teachers · Mediation

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Story comprehension involves cognitive processes, world knowledge and sharing ideas and feelings (Bruner, 1986). Many young children are exposed to stories (narratives) through joint book reading at home and in preschool, and this activity is regarded as a good start for their language development and narrative knowledge (Lynch et al., 2008). Early narrative development has been suggested as a vehicle for reading, reading comprehension and academic success in school (Dickenson & Morse, 2019). As part of the PISA-2018 (OECD, 2019) framework for assessing reading and literacy, different forms of narratives (novels, stories, comics, etc.) are suggested as important genres for children to understand as part of their academic knowledge. PISA-2018 noted the dramatic change in the nature of reading literacy over the two past decades and pointed to the growing presence of digital texts, including narratives. This goes hand-in-hand with our perspective as researchers to share innovative areas of research and pedagogy beyond the traditional notions of literacy and literacy instruction.

Taking all this together, in the present paper we focused on electronic books (e-books) as a tool that can contribute to the acquisition of narrative comprehension among children from low socioeconomic (LSES) families. Ample evidence has shown that young preschoolers from LSES families lag behind children from middle SES (MSES) families in their oral and literacy skills, including story comprehension, pointing to its crucial effect on formal reading in school (Gardner-Neblett & Iruka, 2015). Educators and researchers in many countries are highly motivated to search for and construct methods or new tools for helping young children from LSES families to narrow the literacy gap and minimize it as much as possible before entering school. The few studies available on e-book reading by LSES children show that such books hold the potential for expanding these children's ways of learning beyond the traditional methods (Korat et al., 2012; Verhallen et al., 2006). For example, Korat et al. (2012) examined the effect of direct and indirect teaching of vocabulary and word reading on LSES pre-kindergarteners and kindergarteners following use of an e-book. The children in each age group were randomly assigned to an intervention group which read the e-book or to a control group which received the regular school program. Children who read the e-book exhibited progress in the meaning and reading of the words supported directly by the computer compared to the control group.

Story comprehension in early childhood

Story or narrative theory has a long history in philosophy, literature, and psychology. Brunner (1986) attached great importance to stories in human life since the dawn of culture as a way to build meaning, and defined a story as consisting of an actor or actors with goals and motivations and a temporal sequence of events with causal connections between them (Bruner, 1997). Story comprehension requires the ability to understand explicit information or events that appear clearly in the story

text or pictures, as well as implicit information which might be inferred by understanding temporal or causal relations between events. This includes the ability to distinguish the goal and internal states of the characters and to conceptually integrate different sections of the story (Dempsey & Skarakis-Doylepre, 2019).

Children's story comprehension was described as occurring on three general levels (McNamara & Magliano, 2009). The first level relates to basic understanding of what is said explicitly in the story, including specific details and sequence. The second relates to interpretation and conclusions about information or knowledge which are implied in the story. The third level involves assessment and criticism related to the story, including feelings, thoughts, and personal opinions. Kindergarteners are usually able to understand stories at the explicit level and begin to develop the ability to understand its implicit knowledge (van den Broek et al., 2005). For example, Paris and Paris (2003) found that children (4 to 8; K-2) understood explicit information (character, background, problem) better than inferred knowledge (feelings, inferred causality), while inferred understanding increased significantly with age. Dempsey & Skarakis-Doylepre (2019) found that readers under the age of 3 years grasp only limited elements of explicit story content. Three to five-year-olds, on the other hand, appear to be able to construct fairly detailed representations of a story, even when that story has a complex structure. van den Broek et al. (2005) claimed that preschoolers make inferences and create network representations of the events they experience, and that they use these networks to remember or answer questions. However, their networks are less developed than those of older children or adults. They contain fewer relations and in particular those which are abstract, distant, or involve groups of events, and it is recommended to work with the children on these aspects. As their knowledge, comprehension skills, and processing efficiency expand, their networks become richer and their story comprehension ability improves.

Electronic book

Children, similarly to adults in our era, are surrounded by technology. The innovative technological tools that exist today can help promote story comprehension among young children. One of these tools is the e-book. E-books appear in different forms (e.g., PDF, app) and can be used on various devices, including computers, tablets, smart phones, Kindle, and more. In many children's e-books the story is read by a narrator and is sometimes accompanied by effects such as illumination of the written text, background music, sounds and animations, which lead to a different reading experience than when reading a printed book (Furenes et al., 2021). This reading experience offers various multimodal approaches for the reading of the content, for example reading the text aloud in different voices, speeds, with/without accompanying music, suggesting limited directions on how to navigate the storyline, etc. The variety of multimedia effects and expansions illustrate the connection between the spoken and written text appearing on the screen (Yow & Priyashri,

2019). These clues can help young children understand the storyline and enrich their vocabulary (Takacs et al., 2015).

An important question is raised as to which multimedia effects may support young children's story comprehension and language enhancement when using e-books (Roskos et al., 2009). It was suggested that this might occur with well-designed e-books for young children that expand the story to include information that does not appear in the original story text (usually by animations or "hotspots") which may support storyline understanding and children's language (de Jong & Bus, 2003). This is based on the mediation approach of adults' expansion (or distancing, see Sigel, 1982) beyond the 'here and now' in the adult–child (printed) book reading interaction.

Evidence from the last 15 years shows that many e-books on the commercial market are not supportive for story comprehension and language literacy development (de Jong & Bus, 2003). However, well-designed e-books that include visual and audio facilitations which support and extend the storyline were reported as supporting reading (Wood, 2005), word meaning (Korat et al., 2012; Smeets & Bus, 2012) and story comprehension (Phadung et al., 2016; Wood et al., 2010).

According to the Dual Coding Theory (Paivio, 2008), children learn better when information is presented to them through two channels, the visual and the verbal, than with only one channel (Schnotz, 2005). These two different channels of information, one specializing in objects and events represented visually and the other represented in oral language, are cognitively elaborated by different representation systems. However, they may support and expand the same content. When combining the two channels simultaneously, nonverbal information (images or animations) can help young children understand verbal information and support story comprehension. This learning process is also supported by the idea of synergy, according to which the cooperation of two or more sources of representation (media) yields a better result than each representation alone (Fuller & Applewhite, 1979). In other words, use of multimedia based on these two theoretical models supports language learning, including story comprehension, through synergistic relationships (Neuman et al., 2020).

The term "e-book reading" in our study refers to both listening to a written text and viewing animations, and includes semiotic processes of story comprehension, which might be significantly different from purely text-based comprehension. One of the important questions regarding e-books is whether young children show a good level of story comprehension after listening to/reading these stories. A few studies, which compared children who read an e-book independently to children who were read the printed book by an adult, reported on a good level of comprehension in both formats (Takacs et al., 2014).

As part of the effort to influence the market to produce well-designed e-books, we (Korat & Shamir, 2007, 2010, 2015) developed a model of e-books which can support children's learning by including animations that provide expansions and support to story comprehension. For example, after the narrator finishes reading the story text, an automatic animation which includes comments or discourse between the main characters enriches the story content beyond the text that appears on the screen. In the e-book "Yuval Hamebulbal" (Confused Yuval) (Roth, 2000) (an

e-book version developed by korat et al. 2005), the narrator reads the text, which explains that Yuval (the story's hero) wears his magic hat every morning, and this keeps him from being confused. In an animation that was added to the story text, Yuval, who lies in his bed with his hat, says: "I even go to sleep with my hat, so I will not forget where I put it." The cow in his room yawns aloud, showing that it is bed time. These animations may give the child a wider context and deeper understanding of the main problem presented in the story, and the hero's thoughts about it. Our research indicates that the children showed a medium level of story comprehension after their independent reading of these e-books (75% successes, Korat & Shamir, 2007; Korat 2010). One of the possible explanations for not reaching a higher level is that beyond the multimedia effects of the e-book, young children may need an adult's support and mediation when using technology tools (see American Academy of Pediatrics, 2016).

Adult mediation during E-book reading

According to the Cognitive-Social Theory (Vygotsky, 1978), adult mediation during children's learning activities is important for their progress. It is assumed that children's independent learning ability is realized more effectively through a mediator, who knows how to promote the children's understanding. With this scaffolding, children might reach higher levels of cognitive function, especially those who lag behind (for example, LSES children), who need the instruction of an adult who can make the adaptation between them and the learning environment and organize it for them for better learning. Similarly, Klein (1996) perceived adult support as important for clarifying the meaning of the situation they experience to children, elaborating and expanding it beyond the immediate experience, shaping children's behavior, and providing feedback and encouragement as needed. According to this approach, learning acquired through other human mediation/scaffolding could be more efficient than what is acquired through direct contact with stimuli. Results from recent studies show the importance of adult–child communication during multimedia use (Neuman et al., 2020) and e-book reading (Ferenes et al., in press) for story comprehension.

With the appearance of e-books on the market, and their availability in homes and schools, researchers began to examine processes and effects of children's' independent e-book reading compared to their reading an e-book with an adult's mediation. It was suggested that adult mediation in joint e-book reading may help children use the support provided by the software (e.g., animations, hotspots) more efficiently (Matthew, 1997). This may also help maintain children's attention and prevent them from being distracted from the storyline. In line with these suggestions, some showed an advantage to reading an e-book with adult support compared to children's independent reading by increasing persistence during reading (Moody et al., 2010) and presenting good story comprehension, vocabulary learning, phonological awareness and letter knowledge (Korat, 2010; Ferenes et al., in press). The adult mediation given in these studies was provided by experimenters. Although this situation has

certain advantages, such as meticulous and uniform work, it can be argued that it has low ecological validity, since it does not represent an authentic situation in the educational institution.

In fact, many studies do not implement intervention programs for promoting language and literacy through teachers who work in the researched institutions, and usually use experimenters (Aram, 2006; Roskos & Neuman, 1998). The ability to generalize from these studies regarding their actual application in the kindergarten program is thus limited.

Researchers suggested developing strategies for using e-books in education and argued that mediation during reading is important. It was suggested that despite the unique components of e-books, which enable children to read independently, the presence and mediation of an adult during the reading process might help children to get the most out of this literacy activity (Liang, 2015). They proposed focusing on verbal interactions, including adult mediation during the reading and exploring their effect on children's literacy development. It was also suggested that the literacy potential of e-books can be better realized if they become part of the kindergarten curriculum, in which children and teachers are involved (Parete et al., 2013). Parete and Blum's (2014) model for learning through e-books (Universal Design for Learning-UDL) emphasized three principles: (1) assessment and selection of high-quality e-books, (2) teaching strategies aimed at desirable learning outcomes and (3) integrating the e-books in kindergarten curricula. This is necessary due to the growing number of available e-books, which requires attention to the question of their quality and how to use them effectively in the education system for supporting young children's learning.

Teacher's coaching in E-book reading with young children

One of the questions that can be asked is, whether a well-designed e-book can be a sufficient guide for kindergarten teachers to support children's story comprehension, or whether teachers need specific coaching beyond what the software suggests. Recent work in teachers' professional development (PD) regarding emergent literacy noted the importance of coaching teachers for implementing changes in practices (Egert et al., 2018). McMahon-Morin et al. (2020), for example, showed that trained kindergarten teachers improved children's inferencing abilities in story comprehension more than in classes whose teachers were not coached.

There is evidence that young children who studied in classes in which the teachers who teach language and literacy were given coaching by experts made greater progress compared to those whose teachers did not receive any coaching (L'Allier et al., 2010; McCombs & Marsh, 2009a, 2009b; Wasik & Hindman, 2020). For example, LSES kindergarteners whose teachers received coaching in early literacy teaching showed greater progress in phonological awareness and letter recognition than those whose teachers did not receive coaching (Blachman et al., 1999). Similar results were reported by Aram (2006) and Dickinson and McCabe (2019). Thus, it could be claimed that even if the e-book we suggested to the children is

well designed, teachers can augment children's story comprehension when they are coached to use the e-books more than when children read them independently.

Research aims

In the current research, we examined an intervention program for LSES kindergarteners using e-books we developed for promoting story comprehension assisted by their home teachers. Our study is unique since it aims to extend knowledge on story comprehension programs for young children using e-books within the kindergarten context as part of its curriculum, compared to former studies that used experimenters (Korat, 2010; Sarı et al., 2019). The teachers received coaching on how to support the children in work with e-books from an expert in the field of early literacy. We hypothesized that children who will participate in the program and will read the e-book with expansions and with their teachers' mediation will show greater story comprehension than children who will work independently with the e-book with expansions only. We further hypothesized that children who will read the e-book independently with expansions will comprehend the story better than those who will read it without any expansions (control).

Method

Participants

The participants included 160 Hebrew-speaking kindergarteners from LSES neighborhoods (mean age $M = 5{:}11$, $SD = 0.38$; range 5:03–6:11). Of these, 83 were girls and 77 were boys. SES level was determined according to the Israeli Municipalities' Statistical Report (Central Bureau of Statistics, 2018). Based on this report, we created a list of all kindergartens located in LSES neighborhoods in two cities in the center of Israel. Five kindergartens from the list (out of 24) were randomly chosen for participation. All kindergartens followed a similar national early literacy curriculum, guided by same inspectors. All children were born in Israel and spoke Hebrew fluently.

The five kindergartens were randomly divided into one kindergarten as control (N = 32) and four kindergartens divided into two experimental groups, 2 kindergartens in each (N = 64). The option of dividing the children in each kindergarten into 3 different research groups seemed inappropriate to us, since the home teacher was involved in the intervention program and providing different levels of support to different children was both impractical and unethical. All children in each kindergarten received the same program. In the control group (group 1), the children read the target e-book with the original printed text of the book independently, without any additions for supporting story comprehension. In one experimental group (group 2), the children independently read the e-book with expansions supporting story comprehension. In the second experimental group (group

3), the children read the e-book with expansions supporting story comprehension (as in group 2) with their teachers, who were specifically coached on e-books as a tool for story comprehension support. The three teachers who participated in the study had 5–8 years of teaching experience. All had an early childhood certificate from an Israeli teachers' education college, which usually includes 2 courses in early literacy education instruction.

Research tools

The E-book

The printed book "The Bridge" (Yanish & Benesh, 2011) was converted into a digital version for the purpose of the current study. The story focuses on a giant and a bear who meet in the middle of a long and very narrow bridge, with neither willing to retrace his steps to make room for the other to pass. After two suggestions that could lead to total failure or partial success, the great idea underlying the success of both sides was raised. The giant and the bear hugged each other very tightly and turned to the side each wanted to go. The content of the story seems appropriate for the children's world, who sometimes encounter social situations of struggle for space or object. The story has a classic structure that includes: (a) a background description that relates to the initial state (displays the time and place of the occurrence of the plot, and the participating characters), (b) episodes which describe the presentation of a problem, (c) episodes which describe the problem resolution (see Rumelhart, 1975). The printed book "The Bridge" has 24 pages, whereas the e-book has 12 screens. Every two pages of the printed book were converted into one screen. All screens in the e-book include the original colorful illustrations from the printed book, which cover half the page, and 4–5 sentences (about 30 words) in Hebrew script. See, for example, screen 1 in Fig. 1.

Fig. 1 Screen 1 of the e-book

The e-book includes 2 reading channels: (a) "Read the story", which is a continuous reading of the story by a narrator with no additional support, (b) "Read with expansions", that includes reading the story by a narrator with additions aimed at story comprehension support. At the end of the narration of each screen, animations focusing on specific story content in the screen appear automatically (not as a hotspot which needs clicking). The expansions include repetitions of explicit information appearing in the written text, and by the narrator reading, including the visual information in the book. For example, on screen 2 in the e-book, the narrator reads the text which describes the arrival of the bear and the giant at the bridge on both sides of the bank, and their desire to cross the long and narrow bridge. Then there is a detailed expansion, where a bird flies in sky, passes above the giant, the bear and the bridge, and says: "Twinkle twinkle, the bear and the giant are so big, and the bridge is so narrow." The bird actually repeats what is described on the screen and raises the listener's (or the reader's) attention to the problem that will appear later, when the two large figures (the bear and the giant) will try to cross the narrow bridge at the same time. The automatic animations on the implicit level give support that is at a higher level than the explicit one, since they contain hidden information which was not stated in the story text. In screen 7 the narrator reads the text: "I have a solution, he growls. You just jump into the water, and I can get through. Or you will jump, the giant said. They glared at each other with fury". Then the e-book expansion pops out automatically and the giant and the bear speak and their faces move accordingly. The giant says: "I do not agree with the bear's idea, I will fall into the water, and I cannot swim." Then the bear says (in an angry voice): "I won't jump into the water either, because my fur will get wet." In this case, the purpose of the implicit expansions is to deepen the child's understanding of the characters' thoughts and feelings and to clarify the problem presented in the story.

E-book receptive words knowledge

Similarly to the PPVT test (Dunn & Dunn, 1981), the children were presented with a card presenting 4 pictures and were asked to point to the one which best represents the word that was told them. A correct answer received 1 point. The possible range of scores is 0 to 9. The test includes 9 words, which were chosen following assessment in 2 kindergarten classes located in LSES neighborhoods. In each kindergarten, the teacher read the printed book "The Bridge" to 10 children in small groups of 3–4 children. Along the reading the children were asked for the meaning of 20 verbs, which seemed to the researchers as less familiar to kindergarten-age children. Verbs were chosen since they are considered as more challenging than nouns to kindergarten-age children (see Armon-Lotem, & Berman, 2003). The least familiar verbs from the book were chosen (crossed, roared, stood, looked, nodded, thought, griped, moved and aspired). Cronbach's alpha internal reliability for this test was 0.62.

Children's story comprehension

Story comprehension—statements

Each child was asked 16 true/false questions pertaining to the e-book. The child was asked whether each statement is correct or incorrect. Eight statements were correct, and 8 were incorrect. Furthermore, 8 of the statements were at the explicit level and appeared clearly in the story, and 8 were at the implicit level. An example of a false explicit statement is: "The bear and the giant met after crossing the bridge", since the text clearly states that they met before crossing the bridge and not after. An example of an implicit statement is: "The bear and the giant succeeded in crossing the bridge". This is not explicitly written in the text, but can be inferred from it. A score of 1 was given to a correct answer, and the range is 0–16 points. Cronbach's alpha internal reliability for this test was 0.67.

Story comprehension—open-ended questions

The experimenter presented three key illustrations from the book to the child, one at a time, and asked two questions about each illustration. The illustrations represent the three important narrative components: story background, problem and resolution (Rumelhart, 1975). One question was at the explicit level relating to details, and the second was at the implicit level relating to ideas not stated specifically in the oral reading. A score of 2 was given when a full answer was provided (for example, to the question on the explicit level: *"What did the giant and the bear want to do?"* a possible answer was: *"To cross the bridge to the other side"*). A score of 1 was given when a partial answer was provided (for example, to the question on the explicit level: *"What did the giant and the bear want to do?"* possible answers were: *"Walk on the bridge, pass through the bridge*"). A score of 0 was given when the child said that he/she did not know or did not remember the answer or gave a totally unrelated answer. The total range of the *open-ended questions* test is 0–12. Cronbach's alpha internal reliability was 0.65 and Cohen's kappa inter-rater reliability across two raters was 0.99. The coders were 2 Ph.D. students from the School of Education, one of whom is the second author of this paper.

Procedure

Pretest

All participants were tested individually in the kindergarten in a separate room prior to the intervention. The tests included the e-book receptive words knowledge and story comprehension.

Intervention

The children worked on the e-book in pairs in all three groups. They were instructed to operate the e-book as follows: On one screen one child will hold the mouse and lead the process, and in the next screen the second child will do the same, and so on. In all three groups the children worked with the e-book twice a week for half an hour, with a total of six times over the course of three

weeks. The children in the control group (group 1) worked with the channel "Read the Story", and the children in the experimental groups (groups 2 and 3, 2 kindergartens in each group) worked with the channel "Read with Expansions". Experimental group 2 worked with the channel “Read with Expansions". No coaching for e-book reading was provided. In experimental group 3, the 2 kindergarten teachers were provided coaching on how to work with the e-book. Teachers’ coaching was given individually in 4 meetings. Two meetings took place before the intervention, and 2 meetings were held during the intervention. Each coaching session lasted for 1 h.

The experimenter asked the teachers to create small groups of four children in their class, and to again divide each quartet into two pairs. The teachers were instructed to meet with every quartet twice a week. They were asked to dedicate 10 min of the activity to the children while mediating reading the e-book, and the following 15 min for the children to work in pairs using the e-book by their own implementation. Teachers were coached to activate the story in the expansions menu with the children, to stop the program and ask questions, to respond to them and encourage cooperation between them. For example, on screen number 1, the narrator says: "The river knows a lot of stories. It also knows the story of the great bridge…” The teacher was instructed to draw the children’s attention to the illustration on the screen, and ask them: "Who do you see here in the illustration?" (expansion) "What do you think is the story of "The Great Bridge?" (expansion). At the end of the joint activity, and before starting children’s activities in pairs, the teacher was asked to give the children a specific task which may strengthen their story comprehension by expanding the meaning of the storyline. The kindergarten teachers were instructed to tell the children: "When you finish your reading of the e-book, I will ask you to tell me about the giant in the story: What happened to him? How did he feel? What did he tell the bear?” After that, the teacher addressed the task, which the children received and dedicated 5 min to it. Each reading sessions lasted 30 min. See Appendix A for examples of the protocols of kindergarten teachers’ mediations. The kindergarten teachers wrote a diary in which they reported what they did during the activity, how the children reacted and what problems came up.

The researchers also conducted two observations of the intervention activity in each of the two intervention programs. The observations took place in the second and sixth sessions. In the observation, the researchers focused on a general description of the teacher’s and the children’s activity, as well as on special comments made during the activity. Observations of the activities in each of the three intervention programs and reading the teachers’ diaries showed a good level of fidelity of implementation as suggested by the researchers. This included the number of reading sessions, and teachers’ and children’s behavior in the activities. Teachers coached to work with the e-book closely followed the researcher’s suggestions.

Posttest

The posttest was performed 1 to 3 days after the end of the intervention. It included story comprehension tests.

Results

The children's pre- and post-intervention descriptive statistics of story comprehension measures, which include statements on the story and open-ended questions, are presented in Table 1 in addition to the receptive word knowledge for pre-intervention only. No difference was found between groups in receptive word knowledge ($F = 1.80$, $p > 0.05$). Differences were found between groups in the score of statements on the story ($F = 57.90$, $p < 0.05$). Child's independent reading had a higher score than the other 2 groups (with teachers with coaching and control) and no differences were found between these two groups. Differences were also found pre-intervention between groups on the open-ended questions ($F = 6.60$, $p < 0.05$). Child's independent reading group showed higher results than the group with teachers coaching, followed by the control group. Marginal means and standard deviations are presented for the three sub-groups of time by intervention schedule. Due to the variation across children in their initial performance level, we calculated the differences between pre- and post-intervention measures. Regression models were set to explain progress beyond the children's initial performance. To test group effect on the progress, we performed a one-way analysis of variance on each of the two measures independently, controlled by the pre-intervention values and the receptive words knowledge of the e-book as covariates (analysis of covariance, ANCOVA), such that the preliminary variation across children would not bias the comparisons across groups. These independent

Table 1 Means (and SD) of pre- and post-intervention scores of children's e-book receptive words knowledge and story comprehension

Group	E-book receptive words knowledge	Story comprehension			
		Statements		Open-ended questions	
	Pre	Pre	Post	Pre	Post
Control	36.11 (25.56)	37.50 (11.99)	52.73 (13.74)	16.99 (15.16)	39.26 (13.11)
Child's independent reading	42.19 (17.73)	69.73 (16.07)	79.30 (13.59)	30.27 (20.02)	54.30 (15.34)
Teachers with coaching on e-book	36.46 (15.65)	43.65 (11.65)	85.84 (8.99)	21.88 (14.60)	70.51 (11.27)

Range of scores: 0–100

Table 2 One-way ANCOVA test of progress scores controlled by pre-intervention scores and e-book receptive words knowledge

Group	Story comprehension	
	Statements	Open-ended questions
Control	5.60a (13.65)	17.25a (14.28)
Child's independent reading	20.08b (15.39)	28.12b (19.00)
Teachers with coaching on e-book	36.49c (11.73)	47.05c (16.31)
Effects		
Pre-intervention score		
F(1,155)	103.60***	137.38***
ηp2	.40	.47
Coefficient	− .65***	− .71***
E-book receptive words knowledge		
F(1,155)	5.94*	0.73
ηp2	.04	.005
Coefficient	.11	.05
Group		
F(2,155)	95.52***	71.86***
ηp2	.55	.48

***$p < .001$, ** $p < .01$, * $p < .05$. Lower case Latin letters indicate marginal mean ranking based on Bonferroni pairwise comparisons. Range of scores = 0–100

tests were followed by post-hoc multiple pairwise comparisons with a Bonferroni correction (the critical p-value was set at 0.05/4 = 0.0125).

Table 2 presents ANCOVA results for each of the two research measurements. Contrary to the uncontrolled marginal means in Table 1, the marginal means in Table 2 were controlled by pre-intervention score and word knowledge, such that the marginal means were unbiased by these additional effects.

As can be seen from Tables 1 and 2, a significant group effect was found in the two dependent measures, with a large effect size for story comprehension-statement ($\eta_p^2 = 0.55$) and open-ended questions ($\eta_p^2 = 0.48$). Pre-intervention scores (statements on the story and open-ended questions) were found to negatively affect progress ($b = -0.65$, $p < 0.001$; $b = -0.71$, $p < 0.001$; respectively), also known as the regression to the mean effect, especially when scores are limited from the top and the bottom (100 and 0, respectively). This means that children who had a lower initial score made greater progress compared to their counterparts with a high initial score. However, the e-book receptive words knowledge showed a positive effect on the story comprehension-statement ($b = 0.11$, $F = 5.94$, $p < 0.05$). Thus, children with higher initial e-book receptive words knowledge made greater progress in this story comprehension outcome measure.

The comparison between the groups' performance was executed in a pairwise manner. The final ranking of the groups is expressed in lower case Latin letters, where "a" is set for the lowest mean and so on. As for the story comprehension-statement outcome, group means were ranked from high to low as follows: Children

whose teachers received coaching on the e-book; independent reading; control. Similarly, the highest mean performance for the open-ended questions was found among children whose teachers received coaching on the e-book, while the children in the control group exhibited the lowest progress.

To complete the analysis and to determine factors which affected progress in the children's performance, we ran two regression models of three-steps each, where the dependent variable was the progress in one of the two research measures, and the independent variable in step one was the e-book receptive words knowledge and the initial score in each measure (pre-intervention scores). In step 2, we added two group effects compared to the control group, where the change in R-square indicated the additional explanatory percent due to adding the group effects. In step 3, we constructed an interaction term between groups and e-book receptive words knowledge to assess possible group differences with respect to changing levels of the e-book receptive words knowledge. Sources of these interactions were estimated using the PROCESS procedure (Hayes, 2013), which generates simple slopes and points for

Table 3 Regression analysis for explaining the variance in children's story comprehension and the interactions between them depending on receptive words knowledge and pre-intervention scores

	Story comprehension statements	Story comprehension open-ended questions
Step 1		
E-book receptive words knowledge	.10	.01
Pre-intervention scores	−.66***	−.60***
R^2	.41***	.36***
F	54.07***	42.11***
df	2157	2157
Step 2		
Child's independent reading vs. control	.35***	.25***
Teachers with coaching on e-book vs. control	.74***	.70***
ΔR^2	.33***	.31***
R^2	.74***	.66***
F	107.34***	75.99***
df	4155	4155
Step 3		
Child's independent reading vs. control X E-book receptive words knowledge	−.02	−.06
Teachers with coaching on e-book vs. control X E-book receptive words knowledge	−.10	−.20**
ΔR^2	.01	.02**
R^2	.74***	.69***
F	73.07***	55.64***
df	6153	6153

*** $p < .001$, ** $p < .01$, * $p < .05$

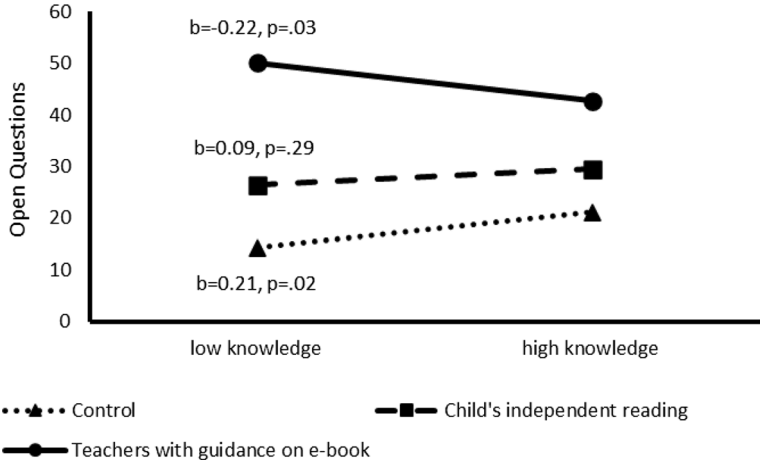

Fig. 2 Simple slope decomposition of the interaction effect between pre-intervention knowledge of receptive words and experimental groups

plotting results, divided between the groups. The results are presented in Table 3 and in Fig. 2.

In step 1, the model results are identical to the ANCOVA, where preliminary scores were found to negatively affect the children's performance. These results from two models complement each other and provide support for the main hypothesis and means that children with a lower initial score made greater progress compared to those with a high initial score. It was also found that the e-book receptive words knowledge did not contribute to the explanation of the two measures. In step 2, it was found that the two intervention groups exhibited greater improvement compared to the control group in both models. In step 3, we found that the differences between the control group and the group whose teacher received coaching on the e-book varied by levels of e-book receptive words knowledge in the open-ended questions outcome performance. This interaction was then decomposed into its sources by three groups. In the control group, the association between the e-book receptive words knowledge and open-ended questions was positive ($b=0.21$, $p=0.02$), whereas in the coaching on the e-book, this association was negative ($b=-0.22$, $p=0.03$). In other words, lower e-book receptive words knowledge was associated with low performance in open-ended story comprehension questions across children in the control group, whereas in the experimental group whose teacher received coaching on the e-book, children with lower initial knowledge receptive words knowledge performed better in open-ended story comprehension questions. These associations were not significant among the other intervention group.

Discussion

The main findings of this study indicate a clear advantage in story comprehension for children who read the e-book with expansions supporting the story content together with the teachers' support. This was followed by children who read the e-book independently with the expansion support. The smallest improvement was found among children who read the e-book independently without any support (control). Children with higher initial e-book receptive words knowledge made greater progress in story comprehension. The results also show that children who received support from their teachers and had low initial receptive knowledge progressed the most in the open-ended questions.

These findings, that show an advantage in story comprehension for children who read the e-book with expansions together with the teachers' support, go hand-in-hand with previous findings which showed that teachers' coaching in language and literacy yielded the best results compared to those whose teachers did not receive coaching (L'Allier et al., 2010; McCombs & Marsh, 2009a, 2009b). These results are important, since they appeared regarding children from low income families, as in our case as well.

Our findings are unique, since they extend knowledge on story comprehension programs for young children using e-books within the kindergarten context. Most studies to date used e-books in kindergarten classes with experimenters (Korat, 2010; Sarı et al., 2019), while in the current research, the e-books were used in the kindergarten class as part of its curriculum by the home teachers. We assume that the e-book design and its inherent potential together with the coaching which the teachers received (using the guidelines for working according to a detailed protocol) helped them promote the children's story comprehension more than those who did not receive such coaching and read the e-book with expansions only. This finding expands previous research on the advantage of parent–child e-book reading compared to children's individual e-book reading for supporting story comprehension (Ferenes et al., in press) and for vocabulary learning, emergent reading, and phonological awareness (Korat, 2010; Korat et al., 2014). Ferenes et al. (in press) for example, in their meta-analysis compared children's story comprehension learning in relation to the book medium (reading on paper versus on-screen), design enhancements in e-books and parent's support for children aged between 1 and 8 years. Parents' mediation during print book reading was found to be more effective than children's individual e-book reading. Our research expands the success of this learning activity with suitable e-books with teachers' support in the context of kindergarten classes as another important vehicle for story comprehension following teachers' coaching (Egert et al., 2018; McMahon-Morin et al., 2020).

The fact that the intervention was carried out by kindergarten teachers in the children's everyday environment in the kindergarten, and not by experimenters, is important. Although researchers generally have better chances of leading uniform interventions, there is the danger that this impact will be for the short term and will not reflect the kindergarten's natural environment (Aram & Biron, 2009; Ukrainetz

et al., 2000). There is a better chance that teachers who are involved in intervention programs in their own class will implement their knowledge in further events in their kindergarten.

Activating the program by the kindergarten teachers allowed us to better answer the question of what is the most effective way to implement kindergarten e-books for promoting understanding in the children's natural learning environment with their home teacher. Reading the e-book with expansions afforded greater support than reading it without expansions (control group). Although the expansions afforded support, the teachers' mediation beyond the e-book expansions served as another important augmentation for the children's story retelling and comprehension.

The findings emphasize the advantage of applying the Dual Coding Theory (Paivio, 2008), which states that children learn better when information is presented to them through the visual and the verbal channels simultaneously, than with only one channel. Furthermore, the results support the Cognitive-Social Theory (Vygotzky, 1978) which highlights the importance of adults' mediation for advancing children's learning. We found that visual images and sounds that appear simultaneously and accompany the verbal text better supported learning processes. Teachers who received coaching used mediated behaviors that focused children's attention, adjusted to their language and story comprehension abilities, asked them questions, and expanded their knowledge and sense of ability.

The kindergarten teachers' mediation was also based on the unique components in the e-book, which supported the story content. The e-book included animations adapted to the abilities of kindergarteners, explaining the story content, as well as allowing the children to listen to the text and the expansions repeatedly. The e-book provided narration of text, animations and text expansion depending on the story content. The teacher focused the children's attention on the illustration that appeared on the screen, asked questions that correspond to the content, re-voiced the expansions and made an effort to strengthen what appeared in the animations. This combination of the teacher's mediation and the e-book support produced the greatest progress for children's comprehension compared to those who read it independently.

As mentioned above, the children who read the e-book independently with expansions progressed more in all measures than the group that read it independently without expansions. These results are important, and support previous studies (Korat, 2010; Sarı et al., 2019) showing that e-books which are well designed to support story content can assist children's story comprehension. In our case, the e-book provided expansions relating to explicit and implicit parts in the story content, which supported understanding it at these two levels, even without an adult's support. This indicates that good quality e-books can be part of the school program for young children to "read" and listen.

As could be expected, the results also showed that children with higher initial e-book receptive words knowledge made greater progress on the story comprehension-statement measure. This follows the principle of "the rich get richer" (Stanovitch, 2000), namely, knowing more words may support your story comprehension in general. However, children's initial level in each comprehension measure (story compression using statements, and open-ended questions) showed a significant negative correlation to this same variable. Thus, the lower the children's initial level in

the measure, the greater their progress in it. These results are important and support previous findings (Korat et al., 2009; Smeets & Bus, 2014) showing that children with a low initial level (e.g., language learners, immigrants' children, or children from LSES families) may benefit the most from the multimedia effects, which include the narrators' reading, effective animations, and adult support. This synergetic effect could be particularly useful for low-achieving children.

More specifically, the findings showed that children in the group which received support from their teachers and had low initial receptive knowledge progressed the most in story comprehension when asked the open-ended questions. This finding clearly demonstrates the advantage of the teachers' coaching together with good quality e-books for low-achieving children. These teachers knew how to use the e-books with children and add their own mediation behaviors to focus the children's attention, ask relevant questions which relate to story comprehension, and expand the children's knowledge based on the e-book expansions. These strategies may be helpful not only for reading e-books, but may also be transferred to printed book reading activities. Future studies are suggested for testing this possibility.

Several limitations of the current research should be noted. A major methodological limitation of the study is that classrooms were assigned to one condition. Although it was important that all children receive the same instruction from their home teacher, future research should address this limitation. Furthermore, a second posttest (about a month or more later) can enable us to examine whether the children's achievements were maintained over time. Such an examination is important for gaining a better understanding of the efficacy of such programs. We also suggest testing children's general vocabulary level as their vocabulary knowledge, in addition to the specific words of the target story. Our story comprehension measures showed low Cronbach's alpha values, and it is possible that they were not very precise in successfully measuring high levels of story comprehension. We need to reconsider how to better use these measures in future studies. We suggest longitudinal studies for understanding the effects of the teachers' mediation with e-books to story comprehension. It is also important to compare interventions with printed books to interventions with e-books in order to highlight the benefits of each.

Our study shows the important role of coaching teachers on how to support the language and literacy of young children in the digital era, and points to possible efficacy in narrowing the language gap in LSES children (Dickenson & Morse, 2019). We recommend enriching kindergarten teachers' knowledge of the structure of e-books, their possibilities, along with principles and operating instructions. This, of course, requires high quality e-books for young children, which can be adjusted to the child's needs and to the adult as mediator.

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